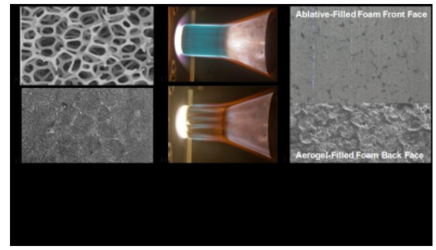
Active Project (2014 - 2016)

Continued Optimization of Low-Density Foam-Reinforced Ablatives for High-Velocity, High Heat Flux Earth Return Missions, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

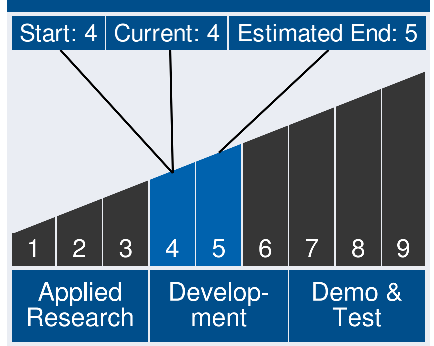
In previous work for NASA, Ultramet and ARA Ablatives Laboratory developed and demonstrated advanced foam-reinforced carbon/phenolic ablators that offer substantially increased performance under high heat flux conditions and reduced weight relative to conventional ablators. The two-piece structure consisted of an ablative-filled foam front surface backed by Ultramet's previously established and highly insulating aerogel-filled foam. Arcjet testing was performed at NASA Ames Research Center to heat flux levels exceeding 1000 W/cm2, with the results showing a significantly reduced ablation rate compared to conventional chopped fiber ablators, and ablation behavior comparable to FM5055 at just one-third the density. It is apparent that the foam helps retain the char layer by physical reinforcement and/or that the network of interconnected passages allows pyrolysis gases to escape with less disruption of the char layer. In Phase I, Ultramet teamed with ARA Ablatives for ablative infiltration of Ultramet foams and Materials Research and Design for ablation analysis, to continue optimization of foam-reinforced ablatives by focusing on two primary areas. The ablator formulation infiltrated into the foam was successfully modified to increase heat flux capability consistent with NASA Earth return requirements (1500-2500 W/cm2 or higher). The density can be varied as needed to meet heat flux requirements while minimizing weight. In addition, a single-piece foam structure was demonstrated, rather than separate ablative- and aerogel-filled foam sections. In Phase II, the lightweight hybrid ablator will be optimized for a specific NASA mission, material and structure requirements will be predicted through modeling, and performance will be demonstrated through high heat flux testing at NASA ARC and the Air Force LHMEL-II facility. Scaleup potential will be demonstrated through fabrication of a heat shield module suitable for construction of large modular heat shields.



Continued Optimization of Low-Density Foam-Reinforced Ablatives for High-Velocity, High Heat Flux Earth Return Missions, Phase II

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed foam-reinforced hybrid ablator-insulator is anticipated to meet NASA requirements for increased TPS heat flux capability and reduced mass. NASA applications include the Orion Multi-Purpose Crew Vehicle for beyond Earth orbit exploration (entry, descent, and landing heat shield and backshell), asteroid sample return, and planetary sample return. Earth return can have an entry velocity greater than 11 km/s and a heat flux in the 1500-2500 W/cm2 range or higher. Use of ablatives in rocket nozzles has been extensive, and NASA also stands to benefit in that application.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Non-NASA applications include solid rocket motors for conventional satellite launch, nanosatellite launch systems, launch platform protection, tactical missile solid rocket motors, internal and external motor case insulation, throats, and nosetips.

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

Project Manager:
- Matthew Gasch

Principal Investigator:
- Brian Williams

Technology Areas

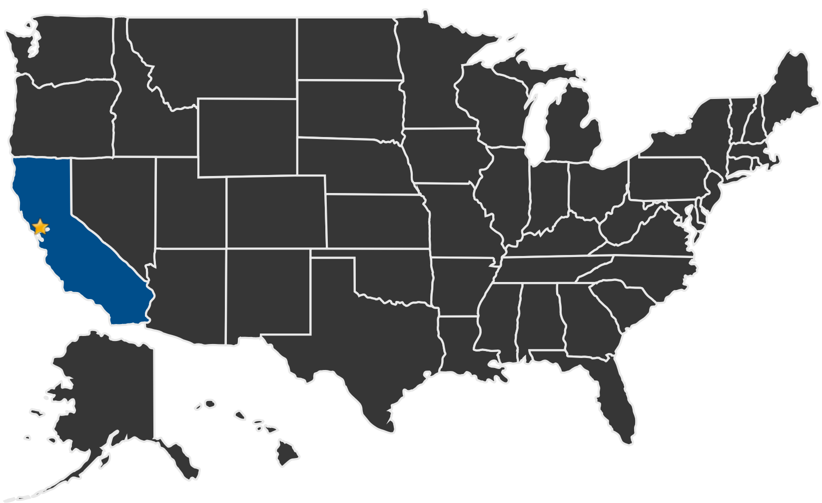
Primary Technology Area:
Thermal Management Systems (TA 14)
└ Cryogenic Systems (TA 14.1)
  └ Passive Thermal Control (TA 14.1.1)
    └ Load Responsive Insulation (TA 14.1.1.1)

Secondary Technology Area:
Human Health, Life Support, and Habitation Systems (TA 6)
└ Environmental Monitoring, Safety, and Emergency Response (TA 6.4)

Entry, Descent, and Landing Systems (TA 9)
└ Aeroassist and Atmospheric Entry (TA 9.1)
  └ Thermal Protection Systems for Rigid Decelerators (TA 9.1.1)

Continued on following page.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Other Organizations Performing Work:

- Ultramet (Pacoima, CA)

DETAILS FOR TECHNOLOGY 1

Technology Title

Continued Optimization of Low-Density Foam-Reinforced Ablatives for High-Velocity, High Heat Flux Earth Return Missions, Phase II

Technology Areas *(cont.)*

Thermal Management Systems (TA 14)
└ Thermal Protection Systems (TA 14.3)
  └ Ascent/Entry TPS (TA 14.3.1)
    └ Obsolescence-Driven Thermal Protection System Materials (TA 14.3.1.2)